

- PATENT COOPERATION TREATY

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner
 US Department of Commerce
 United States Patent and Trademark
 Office, PCT
 2011 South Clark Place Room
 CP2/5C24
 Arlington, VA 22202
 ETATS-UNIS D'AMERIQUE
 in its capacity as elected Office

Date of mailing (day/month/year) 23 November 2000 (23.11.00)	
International application No. PCT/GB00/01162	Applicant's or agent's file reference NG/ARB/19517
International filing date (day/month/year) 24 March 2000 (24.03.00)	Priority date (day/month/year) 26 March 1999 (26.03.99)
Applicant McGARIAN, Bruce et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:
 24 October 2000 (24.10.00)

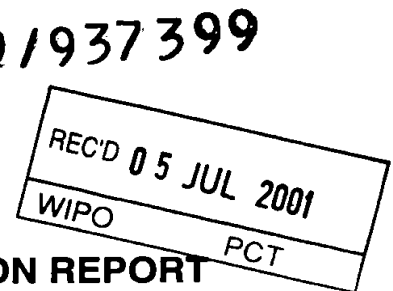
☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was

☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Juan Cruz Telephone No.: (41-22) 338.83.38
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Applicant's or agent's file reference NG/ARB/19517		FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/GB00/01162	International filing date (day/month/year) 24/03/2000	Priority date (day/month/year) 26/03/1999	
International Patent Classification (IPC) or national classification and IPC E21B7/06			
Applicant SMITH INTERNATIONAL, INC.			



- This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
- This REPORT consists of a total of 8 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

 These annexes consist of a total of 7 sheets.

- This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand 24/10/2000	Date of completion of this report 03.07.2001
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Georgescu, M Telephone No. +49 89 2399 7502 

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/01162

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, pages:

1,3,4,6	as originally filed			
2,5	as received on	04/05/2001	with letter of	04/05/2001

Claims, No.:

1-15	as received on	04/05/2001	with letter of	04/05/2001
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Drawings, sheets:

1/2,2/2	as originally filed
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2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/01162

- ☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims 1-15
	No: Claims
Inventive step (IS)	Yes: Claims
	No: Claims 1-15
Industrial applicability (IA)	Yes: Claims 1-15
	No: Claims

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

Reference is made to the following documents:

D1: WO 98 04804

In compliance with Art 33.6 PCT and PCT\GL\C VI 7.24

D2: GB 2 312 702 A is considered (as it is mentioned in the description).

V - Reasoned statement under Rule 66.2 (a)(ii)

In the light of the inconsistencies pointed out in Section VIII, the novelty and the inventive step will be assessed as follows:

V-1 Claim 1

D1, which is considered as the closest prior art, describes a whipstock casing milling system (fig.17a, page 12, lines 34-35) for forming a window in the casing of a wellbore, the casing having an inwardly facing surface which defines the inside diameter of the casing and an outwardly facing surface which defines the outside diameter of the casing (fig. 17a to 17c), the whipstock casing milling system comprising: a whipstock (297) having a whipface (296), the whipface comprising a relatively steep ramp surface (between the upper end of the hidden line at the upper end of the whipstock and the left wall of the casing 282) and a relatively shallow ramp surface (the rest of whipface 296) meeting the relatively steep ramp surface at a juncture (illustrated by the upper end of the hidden line in fig.17a), said surfaces being ramped relative to the longitudinal axis of the whipstock (fig.17a) and the relatively steep ramp surface having an angle to the longitudinal axis of the whipstock greater than that of the relatively shallow ramp surface (fig.17a, see also VIII-1); a window mill (280) secured to the whipstock (page 13, lines 7-9, see also fig.17a) adjacent to the relatively steep ramp surface (fig.17a) and operable in use to form an opening in a wellbore casing in which the whipstock casing milling system is located, the window mill being deflected by the relatively steep ramp surface laterally into the casing as the window mill is rotated and forced along the relatively steep ramp surface towards the relatively shallow ramp (see the sequence of fig. 17a, 17b, 17c; furthermore, the aforementioned structural features make impossible to acknowledge any difference, explicit or **implicit**, between the apparatus of claim 1 and D1); and a protrusion (288)

provided on the whipface (fig.17a), the protrusion forming an extension of the relatively steep ramp surface (fig.17a) of the whipface, wherein the protrusion (288) reduces damage to the relatively steep ramp surface (one of the technical problems to be solved by D1 is to prevent the mill damaging the whipstock - page 2, lines 4-6; the result can be seen in fig.17b where the steep ramp surface is not destroyed, meaning that the damages are reduced due to the use of said protrusion).

The distinguishing feature of claim 1 with regard to D1 is that "during use ... outwardly facing surface of casing".

The subject-matter of claim 1 is therefore new and the claim meets the novelty requirement of Art. 33(2)PCT.

The milling system of D1 would have also the aforementioned distinguishing feature just by using it in different wellbores, one of which would have the appropriate thickness of the casing so that the dimensional relationship of said distinguishing feature would be the same. Thus, said feature would be merely the result of a trial and error process and therefore claim 1 does not meet the requirement for inventive step of Art. 33(3) PCT.

V-2 Claim 2

The feature of the cutting face with identical angle to the one of the steep ramp surface is known from D1 (fig.17a). The specific annular cutting surface of the mill is merely an alternative to the mill of D1 and the particular radial thickness of said annular cutting surface is merely the result of a trial and error process performed by the skilled man in order to reduce damages of said steep ramp surface. Therefore, claim 2 does not meet the requirement for inventive step of Art. 33(3) PCT.

V-3 Claim 3 and 6

The distinguishing feature of claim 3 is also known from D1 (fig.17a).

The feature of claim 6 is known from D1 (fig.17a).

Therefore, claims 3 and 6 do not meet the requirement for novelty of Art. 33(2) PCT.

V-4 Claims 4 and 5

The distinguishing features of claims 4 and 5 are merely normal design possibilities which would be obvious for the skilled man to apply to the device of D1 in order to use the same system more than once. Therefore, claims 4 and 5 do not meet the requirement for inventive step of Art. 33(3) PCT.

V-5 Claim 7

D2 describes a similar whipstock system (fig.4) where the relatively steep ramp surface (45) has a steep angle of 15° which helps minimizing the damage to the whipstock (page 10, lines 19-20). Due to the fact that both D1 and D2 are in the same technical field and deal with the same problem of milling a window in a well casing while minimizing the damage to the whipstock, it would be obvious for the skilled man to apply the teaching of D2 to the device of D1. Furthermore, the precise value of the angle would be straightforward to determine also as the result of a trial and error process which does not involve an inventive step either (PCT\GL\C IV 8.8.(C1)(ii)). Therefore, claim 7 does not meet the requirement for inventive step of Art. 33(3) PCT.

V-6 Claim 9

D2 which is considered the closest prior art describes a method with a similar dimensional relationship (fig.4, 6B). In D2 (page 10, lines 19-20) as well as in D1 (page 2, lines 4-6) is present the common concern of reducing the damages made by the mill to the whipstock. Thus, the skilled man would not hesitate to apply the teaching of D1 with regard the protrusion which extends the steep ramp surface in order to further reduce said damages. Therefore, claim 9 does not meet the requirement of Art. 33(3) PCT.

V-7 Claim 10

D1 describes a milling system like in the preamble of claim 10. The distinguishing feature of claim 10 with regard to D1 is merely a normal design possibility. Therefore claim 10 does not meet the requirement for inventive step of Art. 33(3) PCT.

V-8 Claims 10 to 15

For claims 10 to 15 apply the arguments for the corresponding claims 2 to 6.

VII - Certain defects

- VII-1 The independent claim 1 is not properly casted in the two part form, with those features which in combination are part of the closest prior art (D1) being placed in the preamble, contrary to the requirements of Rule 6.3(b) PCT.

VIII - Certain observations (clarity)

- VIII-1 The relative terms "relatively steep", "relatively shallow" used in the claims have no clear technical meaning and leave the reader in doubt as to the meaning of the technical features to which they really refer, thereby rendering the definition of the subject-matter of the claims difficult to determine (Article 6 PCT). The definition of the terms "steep" and "shallow", with regard to the longitudinal axis of the whipstock is understood considering clockwise the angle comprised under the surfaces in question. The way of measuring these angles should have been specified by the applicant, as otherwise said angles could be considered also counterclockwise above said surfaces which could result in having the angle of the "steep" surface smaller than the one of the "shallow" surface with regard to said axis.
- VIII-2 The distinguishing feature of claim 1 is not a structural feature of the claimed apparatus but a use feature. Furthermore, said feature is formulated with

elements of the casing (diameter and thickness) which is not claimed together with the milling system and subsequently do not belong to the apparatus. Therefore, claim 1 does not comply with the requirements of Art. 6 PCT as it does not allow to clearly define the scope of protection of the claim.

VIII-3 Although claims 1 and 10 have been drafted as separate independent claims, they appear to relate effectively to the same subject-matter and to differ from each other only with regard to the definition of the subject-matter for which protection is sought. The aforementioned claims therefore lack conciseness.

Hence, claims 1 and 10 do not meet the requirements of Article 6 PCT.

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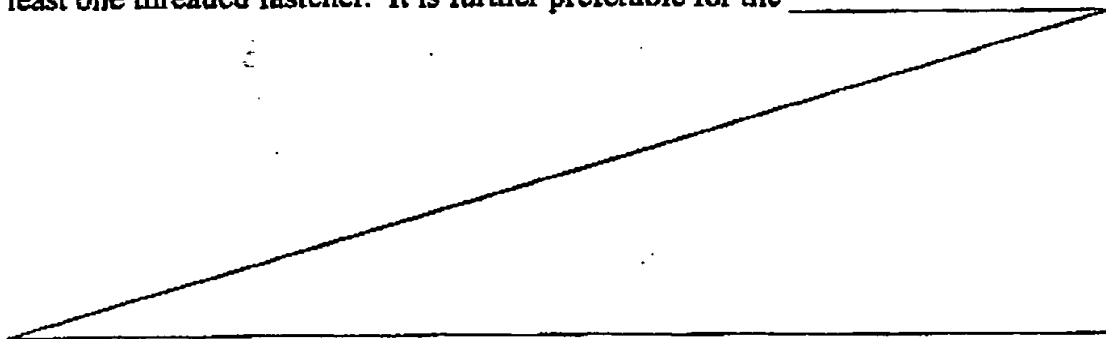
inevitably occur. One result of this wear is that the window in the casing is not opened up as quickly as might be expected from the initial (pre-wear) profile of the whipstock. One prior art system according to the preamble of the appended claims (disclosed under international publication number WO 98/04804) provides a partial solution to this problem, but does not necessarily allow prevention of undesirable ramp wear under given conditions.

We have now devised a complete solution to the aforementioned problem.

A first aspect of the present invention provides a whipstock casing milling system according to the appended independent claim 1. A further aspect of the present invention provides a whipstock casing milling system according to the appended independent claim 9. A further advantageous feature is defined in the appended dependent claims 2 and 10. A yet further aspect of the present invention provides a method of using a window casing milling system according to appended independent claim 8.

The protrusion will, in practice, be milled partially or completely away during the casing milling operation. However, the existence of the protrusion prevents the excessive damage to the relatively steep ramp surface of the whipface such as has occurred in the prior art. The protrusion may be of any suitable material, for example steel of a suitable grade.

Ideally, the protrusion is provided on the relatively shallow ramp surface or parallel surface of the whipface. Preferably, the protrusion is removably secured to the whipface. The protrusion may be movably secured by means of at least one threaded fastener. It is further preferable for the



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circumstances (including, for example, the relative hardness of the whipstock and the well casing), the angle of the starter surface 45 can, in an extreme case be reduced to zero (see Figure 4). In this event, a window in the well casing will not be formed.

Referring now to Figure 5, the above outlined problem is solved by means of a protrusion B which is provided on the whipface immediately below the lower end of the starter surface 45. The protrusion B in effect extends the starter surface 45 downwardly of the well. The effect of the protrusion is to provide extra support for the reaction forces imposed on the whipface by the window mill and thereby reduce or prevent the undesired wearing away of the starter surface 45 itself. In practice, the protrusion will in general be milled away in use by the window mill. However, the existence of the protrusion ensures that adequate lateral movement of the window mill is achieved before the window mill starts travelling down the vertical surface 46. The protrusion can be of any suitable material and can be secured to the whipface by any convenient means, for example by means of screws or by welding.

Use of a whipstock casing milling system according to the present invention is shown in Figures 6, 7 and 8 of the accompanying drawings. In Figure 6, the window mill 32 is shown at the foot of the steep starter surface 45 prior to commencing cutting of the well casing. As the window mill 32 is pushed up the starter surface 45, the bearing area initially remains constant due to the provision of the protrusion B. It is only as the window mill 32 is pushed beyond the extended starter surface 45 (see Figure 7) that the bearing area begins to reduce. This reduction in bearing area contributes to an increase in the stress within the starter surface 45 and the extension provided by protrusion B. However, the protrusion B is sized so that starter surface 45 is sufficiently extended for attainment of the critical stress level to be delayed until the required lateral displacement of the window mill 32 has occurred. As intimated _____

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CLAIMS:

1. A whipstock casing milling system for forming a window in the casing of a wellbore, the casing having an inwardly facing surface which defines the inside diameter of the casing and an outwardly facing surface which defines the outside diameter of the casing, the whipstock casing milling system comprising: a whipstock (44) having a whipface, the whipface comprising a relatively steep ramp surface (45) and a relatively shallow ramp surface or parallel surface (46) meeting the relatively steep ramp surface (45) at a juncture (A), said surfaces (45,46) being ramped or parallel relative to the longitudinal axis of the whipstock (44) and the relatively steep ramp surface having an angle to the longitudinal axis of the whipstock greater than that of the relatively shallow ramp surface or parallel surface; a window mill (32) secured to the whipstock (44) adjacent the relatively steep ramp surface (45) and operable in use to form an opening in a wellbore casing in which the whipstock casing milling system is located, the window mill (32) being deflected by the relatively steep ramp surface (45) laterally into the casing as the window mill (32) is rotated and forced along the relatively steep ramp surface (45) towards the relatively shallow ramp or parallel surface (46); and a protrusion (B) provided on the whipface, the protrusion (B) forming an extension of the relatively steep ramp surface (45) of the whipface, characterised in that, during use of the system, the diameter of the window mill (32) is greater than the distance from the juncture (A) to the radially opposite outwardly facing surface of casing, and in that the protrusion (B) reduces damage to the relatively steep ramp surface (45).

2. A whipstock casing milling system as claimed in claim 1, wherein the window mill (32) comprises a cutting surface arranged with an angle to the rotational axis of the window mill substantially identical to the angle of the relatively steep ramp surface (45) to the longitudinal axis of the whipstock, said cutting surface occupying an annular zone centred on the rotational axis of the

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window mill (32) and having a radial thickness greater than the radial thickness of the protrusion (B).

3. A whipstock casing milling system as claimed in claim 1 or 2, wherein the protrusion (B) is provided on the relatively shallow ramp or parallel surface (46) of the whipface.
4. A whipstock casing milling system as claimed in any of the preceding claims, wherein the protrusion (B) is removably secured to the whipface.
5. A whipstock casing milling system as claimed in claim 3, wherein the protrusion (B) is removably secured to the whipface by means of at least one threaded fastener.
6. A whipstock casing milling system as claimed in any of the preceding claims, wherein the protrusion (B) comprises a surface which is ramped at the same angle relative to the longitudinal axis of the whipstock (44) as the relatively steep ramp surface (45).
7. A whipstock casing milling system as claimed in claim 6, wherein said ramped surface of the protrusion (B) and the relatively steep ramp surface (45) are ramped at an angle of 15° relative to the longitudinal axis of the whipstock (44).
8. A method of using a whipstock casing milling system for forming a window in the casing of a wellbore, the casing having an inwardly facing surface which defines the inside diameter of the casing and an outwardly facing surface which defines the outside diameter of the casing, the whipstock casing milling system comprising: a whipstock (44) having a whipface, the whipface comprising

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a relatively steep ramp surface (45) and a relatively shallow ramp surface or parallel surface (46) meeting the relatively steep ramp surface (45) at a juncture (A), said surfaces (45,46) being ramped or parallel relative to the longitudinal axis of the whipstock (44), and the relatively steep ramp surface having an angle to the longitudinal axis of the whipstock greater than that of the relatively shallow ramp surface or parallel surface; a window mill (32) secured to the whipstock (44) adjacent the relatively steep ramp surface (45) and operable in use to form an opening in a wellbore casing in which the whipstock casing milling system is located, the window mill (32) being deflected by the relatively steep ramp surface (45) laterally into the casing as the window mill (32) is rotated and forced along the relatively steep ramp surface (45) towards the relatively shallow ramp or parallel surface (46); and a protrusion (B) provided on the whipface, the protrusion (B) forming an extension of the relatively steep ramp surface (45) of the whipface during use of the system; wherein the method comprises the step of locating said whipstock casing milling system in a wellbore casing so that the juncture (A) and the radially opposite outwardly facing surface of casing are spaced from one another by a distance less than the diameter of the window mill (32).

9. A whipstock casing milling system comprising: a whipstock (44) having a whipface, the whipface comprising a relatively steep ramp surface (45) and a relatively shallow ramp surface or parallel surface (46) meeting the relatively steep ramp surface (45) at a juncture (A), said surfaces (45,46) being ramped or parallel relative to the longitudinal axis of the whipstock (44) and the relatively steep ramp surface having an angle to the longitudinal axis of the whipstock greater than that of the relatively shallow ramp surface or parallel surface; a window mill (32) secured to the whipstock (44) adjacent the relatively steep ramp surface (45) and operable in use to form an opening in a wellbore casing in which the whipstock casing milling system is located, the window mill (32) being deflected by the relatively steep ramp surface (45) laterally into the casing as the window mill (32)

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is rotated and forced along the relatively steep ramp surface (45) towards the relatively shallow ramp or parallel surface (46); and a protrusion (B) provided on the whipface, the protrusion (B) forming an extension of the relatively steep ramp surface (45) of the whipface so as to reduce damage to the relatively steep ramp surface (45) at the juncture (A) of the relatively steep ramp surface (45) and the relatively shallow ramp or parallel surface (46) during use of the system; the whipstock casing milling system being characterised in that the protrusion (B) and whipstock (44) are discrete components.

10. A whipstock casing milling system as claimed in claim 9, wherein the window mill (32) comprises a cutting surface arranged with an angle to the rotational axis of the window mill substantially identical to the angle of the relatively steep ramp surface (45) to the longitudinal axis of the whipstock, said cutting surface occupying an annular zone centred on the rotational axis of the window mill (32) and having a radial thickness greater than the radial thickness of the protrusion (B).
11. A whipstock casing milling system as claimed in claim 9 or 10, wherein the protrusion (B) is provided on the relatively shallow ramp or parallel surface (46) of the whipface.
12. A whipstock casing milling system as claimed in any of claims 9 to 11, wherein the protrusion (B) is removably secured to the whipface.
13. A whipstock casing milling system as claimed in claim 12, wherein the protrusion (B) is removably secured to the whipface by means of at least one threaded fastener.
14. A whipstock casing milling system as claimed in any of claims 9 to 13, wherein the protrusion (B) comprises a surface which is ramped at the same

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angle relative to the longitudinal axis of the whipstock (44) as the relatively steep ramp surface (45).

15. A whipstock casing milling system as claimed in claim 14, wherein said ramped surface of the protrusion (B) and the relatively steep ramp surface (45) are ramped at an angle of 15° relative to the longitudinal axis of the whipstock (44).

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference NG/ARB/19517	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/GB 00/01162	International filing date (day/month/year) 24/03/2000	(Earliest) Priority Date (day/month/year) 26/03/1999
Applicant SMITH INTERNATIONAL, INC.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the language, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international search was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

2. ☐ Certain claims were found unsearchable (See Box I).

3. ☐ Unity of invention is lacking (see Box II).

4. With regard to the title,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the abstract,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is Figure No.

☐ as suggested by the applicant.

☒ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

5
☐ None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 00/01162

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E21B7/06 E21B29/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 551 509 A (BRADDICK BRITT O) 3 September 1996 (1996-09-03) column 7, line 28 - line 44; figure 6	1,2,6
Y	---	3-5
Y	US 5 787 978 A (PLEASANTS CHARLES W ET AL) 4 August 1998 (1998-08-04) column 12, line 56 - line 64; figure 6 column 16, line 40 - line 51; figure 10 column 16, line 52 - line 56; figure 17	3,4
Y	US 5 595 247 A (BRADDICK BRITT O) 21 January 1997 (1997-01-21) column 14, line 40 - line 58; figure 9 ---	5

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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"S" document member of the same patent family

Date of the actual completion of the international search

6 June 2000

Date of mailing of the international search report

14/06/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
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Fax: (+31-70) 340-3016

Authorized officer

Dantinne, P

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 00/01162

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>WO 98 04804 A (LUCAS BRIAN RONALD ;WEATHERFORD LAMB (US)) 5 February 1998 (1998-02-05) column 13, line 7 - line 22; figure 17 -----</p>	1-6

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 00/01162

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5551509	A	03-09-1996	CA 2164773 A	25-09-1996
			GB 2299106 A,B	25-09-1996
			GB 2324110 A,B	14-10-1998
			GB 2328968 A,B	10-03-1999
			US 5647436 A	15-07-1997
US 5787978	A	04-08-1998	US 5620051 A	15-04-1997
			US 5522461 A	04-06-1996
			US 5720349 A	24-02-1998
			AU 5059498 A	10-06-1998
			EP 0948700 A	13-10-1999
			WO 9822689 A	28-05-1998
			NO 991647 A	07-07-1999
			US 6056056 A	02-05-2000
			US 5887655 A	30-03-1999
			US 5887668 A	30-03-1999
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